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Estimates of Willingness to Pay for Pollution-Induced Changes in Morbidity A Critique for Benefit-Cost Analysis of Pollution Regulation. Executive Summary

Energy and Resource Consultants, Inc.
Boulder, CO

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Executive Summary Estimates of Willingness to Pay for Pollution-Induced Changes in Morbidity: A Critique for Benefit Cost Analysis of Pollution Regulation

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16. Abstract (Limit: 200 words) Critique of existing literature on the willingness to pay, by individuals and by society, for changes in morbidity. The critique concentrates on empirical analyses. Four approaches are examined: (1) health production function studies that specify a relationship between a person's health and his expenditures of time and money in response to and for prevention of illness; (2) cost of illness studies that estimate primarily the medical expenditures and income lost due to being sick; (3) contingent valuation surveys designed to elicit willingness to pay (or accept) from individual respondents; and (4) health status indexes from the psychology and public health literature that typically involve a subjective weighting or ranking of different states of health. The practicality of each approach is evaluated along with factors that influence each measure and its conceptual appropriateness for valuing changes in morbidity. Tentative conclusions are offered regarding potential usefulness of the approaches for evaluating morbidity changes expected from pollution control. (Executive Summary)

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EXECUTIVE SUMMARY

ESTIMATES OF WILLINGNESS TO PAY FOR POLLUTION-INDUCED CHANGES IN MORBIDITY: A CRITIQUE FOR BENEFIT-COST ANALYSIS OF POLLUTION REGULATION

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EXECUTIVE SUMMARY

PURPOSE AND GOALS OF THE REPORT

This report reviews estimates of willingness to pay for the reduction or prevention of pollution-induced morbidity. Its purpose is to provide information that may assist in decisions concerning the regulation of environmental pollution. An important motivation for this review is Executive Order 12291, which requires an assessment of potential benefits and costs before any major regulation is adopted. Benefits and costs are to be quantified in dollar terms whenever possible. Although the protection of human health is only one type of benefit from regulating impacts on the environment, it may be the most important. Whenever such benefits can be estimated in dollar terms, comparison with other types of benefits, and with costs, will be facilitated.

This review critiques studies that have estimated willingness to pay (WTP) and willingness to accept compensation (WTA), and related efforts, specifically for changes in morbidity. Four types of studies are reviewed:

1) Health production function (HPF) studies specify a relationship between the individual's health and his expenditures of time and money in response to and for prevention of illness. These studies provide a theoretical analysis of the determinants of an individual's WTP (WTA) for changes in morbidity and some preliminary empirical estimates have been based on this approach.

2) Cost of illness (COI) studies typically estimate the direct and indirect dollar costs associated with illness, which consist primarily of medical expenditures and income lost due to being sick. COI estimates are not equivalent to WTP (WTA) estimates for changes in morbidity, but under some circumstances they may provide a lower bound. There is an extensive COI literature and a wide range of applications. Two important COI studies are reviewed in detail and issues in

applying COI methods for morbidity related to environmental pollution are discussed.

3) Contingent valuation (CV) approaches use surveys designed to elicit WTP or WTA estimates from individual respondents. These approaches are in developmental stages when it comes to estimating WTP (WTA) for changes in pollution related morbidity. Five empirical estimates are reviewed.

4) The health status index (HSI) research, from the psychology and public health literature research typically involves a subjective weighting or rating of different states of health in order to evaluate programs with different kinds of health outcomes. These studies do not provide estimates of WTP (WTA), but they provide information about the relative disutility of different types of morbidity. They also suggest some directions for future research efforts to estimate the WTP or WTA for changes in morbidity.

ECONOMIC CONCEPTS OF BENEFITS FOR CHANGES IN MORBIDITY

The motivation for this review is the desire to develop dollar estimates of the benefits of reducing or preventing morbidity due to environmental pollution. These estimates may then be used in benefit-cost analysis of environmental regulations. Conversely, such values can be used in estimating the loss of health benefits if environmental regulations are relaxed. Economic theory suggests that the appropriate measure of the social benefit of any program should reflect the total increase in well-being that it provides for everyone whom it affects. Maximum WTP (and minimum WTA) reflect how much of other goods and services the individual is willing to give up in order to obtain a reduction or prevent an increase in morbidity for himself and for others. This, therefore, gives a dollar measure of the change in well-being that the individual expects to experience. Summing this measure of maximum individual WTP across all affected individuals provides an estimate of the total social benefits.

SUMMARY OF CONCLUSIONS

A summary of the studies reviewed in this report is provided in Table 1. Overall, very few satisfactory estimates of WTP for changes in morbidity have been obtained. COI studies currently provide the most comprehensive information on morbidity ben fits, but theoretical analysis (Harrington and Portney, 1982) and empirical evidence (Rowe and Chestnut, 1984) suggest that these estimates understate society's total WTP for changes in morbidity. On the positive side, the lower bound estimates provided by the COI measure are useful in benefit-cost studies and for most ap lications represent the best information currently available. The CV approach to estimating WTP (WTA) for changes in pollution-induced morbidity is promising, but has had limited application. Two CV studies provide WTP estimates for specific kinds of respiratory symptoms, which may be useful for policy decisions regarding those kinds of health effects. The HPF studies have not provided very useful WTP estimates to date due to data limitations or restrictive theoretical assumptions, but they have provided useful conceptual analyses of the morbidity valuation problem. The conceptual contributions of the HPF studies illustrate the limitations of the COI estimates and provide insights that could prove useful in performing CV studies. The extensive data requirements of the HPF approach for estimating WTP (WTA) for changes in morbidity are problematic. The HSI studies provide interesting descriptions and rankings of health states but have not estimated WTP. The reviews of these studies are summarized below.

Some general points have emerged during this review that are important to consider in any application of estimates of WTP (WTA) for changes in morbidity, whether new estimates are being made or whether estimates from previous studies are being applied.

1. <u>Society's WTP and the individual's WTP may differ.</u> What an individual is willing to pay to prevent or reduce his own morbidity may differ from what society is willing to pay due to the availability of subsidized medical care and sick leave, due to the worry and inconvenience suffered by family and friends, and due to the altruism of others. It is possible to have a comprehensive theoretical definition of the individual's WTP (WTA) as that which he is willing to pay to prevent or reduce his own and others' morbidity, but empirical estimates may or may not be comprehensive depending on how they are obtained. An evaluation of public policy requires consideration of all costs and benefits to society, so analysts should be clear about whether they have estimates of the individuals' or society's WTP (WTA).

Table 1

Summary of Studies Reviewed

Authors (Year)	Type of Approach	Brief Description	Crucial Assumptions	Data Sources	Important Findings (1983 dollars)	Usefulness for Pollution-Related Morbidity Valuation and Other Comments
Cropper (1981)	Health production function	An expression for WTP for changes in pollution was derived from a health production function model, and estimated for employed men ages 18 to 45 with work loss days as the measure of time spent sick and SO_2 as the pollution measure.	- Health affects the individual's well-being only via changes in time lost from work and in health enhancing or protecting expenditures. - Specific functional forms were assumed for the relationships in the model	Michigan Panel of Income Dynamics for 1970, 1974 and 1976.	The outcome of the theoretical analysis was that WTP is 2 times the value of time lost due to illness.	The usefulness is limited due to the restrictive assumptions of the model.
Gerking et al. (1983)	Health production function	An expression for WTP for changes in pollution was derived from a health production function model that incorporated direct utility effects of health. The WTP expression was then estimated for St. Louis residents and air pollution effects on health.	Individuals are able to obtain an optimal amount of preventive medical care and other defensive efforts such that the marginal costs equal the marginal benefits.	St. Louis Health Survey	The outcome of the theoretical analysis was that WTP can be expressed in relationships that are potentially observable.	The WTP estimates obtained are not useful for policy analysis due primarily to the limitations of the data used.
Harrington and Portney (1982)	Health production function	A health production function model was used to analyze the components of WTP for changes in pollution.	- Individuals are able to obtain an optimal amount of preventive medical care and other defensive efforts such that the marginal costs equal the marginal benefits. - The health production function is such that when pollution increases defensive efforts do not decrease and/or health does not improve.	None	The outcome of the theoretical analysis was that the individual's WTP can be expected to exceed COI incurred by the individuals.	The conclusions of the analysis support the use of COI estimates for as a lower bound for WTP.

Table 1

Summary of Studies Reviewed

(continued)

Authors (Year)	Type of Approach	Brief Description	Crucial Assumptions	Data Sources	Important Findings (1983 dollars)	Usefulness for Pollution-Related Morbidity Valuation and Other Comments
Cooper and Rice (1976)	Cost of illness — prevalence based	Developed cost of illness estimates covering medical expenditures and productivity losses due to all illness for 1972 for the U.S. divided into 16 major disease categories.	All costs were allocated according to primary diagnosis.	- National Center for Health Statistics - Health Care Financing Administration - National Diseases and Therapeutic Index - Current Population Survey	- Total direct medical expenditures in 1972 were $179,050 million. - Total productivity losses due to morbidity in 1972 were $100,728 million.	The results can be used to estimate a lower bound on WTP for broad categories of illnesses when prevalence based costs are relevant and when the portion of illness (and costs) attributable to pollution can be estimated.
Hartunian et al. (1980, 1981)	Cost of illness — incidence based	Developed incidence based cost of illness methodology and estimates for 1975 for categories of disease: cancer, stroke, coronary heart disease and motor vehicle injuries.	Projections of future costs for cases begun in 1975 can be approximated by costs of previous cases.	Many -- see Table 3.9 (in full report)	- Incidence based costs are quite different than prevalence based costs. - Average total cost per incident (present value): Cancer: $64,818 Stroke: $47,232 Coronary Heart Disease: $38,450 Motor Vehicle Accidents: $6,253	The results can be used to estimate a lower bound on WTP for these categories of illnesses when incidence based costs are relevant and when the portion of illness (and costs) attributable to pollution can be estimated. Note: The reported results include losses due to premature death as well as morbidity.

Table 1

Summary of Studies Reviewed

(continued)

Authors (Year)	Type of Approach	Brief Description	Crucial Assumptions	Data Sources	Important Findings (1983 dollars)	Usefulness for Pollution-Related Morbidity Valuation and Other Comments
Loehman et al. (1979) and Loehman and De (1982)	Contingent valuation	A mail survey of Tampa, Florida, residents obtained WTP estimates for avoidance of minor and severe respiratory symptoms for 1 day, 1 week or 3 months each year.	- Mail survey is adequate for CV approach. - Preference for use of median rather than mean WTP.	General population survey	- Estimated median WTP for avoidance of 1 day of respiratory symptoms: minor - $3 to $8 severe - $11 to $18 - WTP was much higher for those without medical insurance. - WTP influenced by current health status.	- Relevant for short term respiratory symptoms. - Ambiguity in reference to decreases in existing symptoms or prevention of additional symptoms makes responses for 1 week and 3 months especially suspect.
Rowe and Chestnut (1984)	Contingent valuation	A study of asthmatics in a high pollution area near Los Angeles, in conjunction with a UCLA epidemiological study, to explore WTP versus COI for reductions in asthma symptoms and mitigating behavior.	- Use of individual defined "bad asthma day". - Ranking of benefits of reducing asthma symptoms can be interpreted so that WTP for benefits would be in same order.	Survey of a panel of asthmatics	- Mean WTP for a 50% reduction in "bad asthma days" per year: $400 or $21 per "bad asthma day" reduced. - Individual's WTP exceeds COI incurred by the individual by 1.6 to 2.3 times. - Provides evidence that mitigating behavior does occur.	- Relevant for valuation of impacts of air pollution as it aggravates asthma. - Conclusion that WTP exceeds COI 1.6 to 2.3 times is subject to interpretation of the rankings of benefits.
Brookshire et al. (1979)	Contingent valuation	Survey of Los Angeles area residents concerning WTP for reductions in air pollution, separating acute and chronic health effects and visibility effects.	- WTP to prevent health and aesthetic impacts are additive. - General public is able to reasonably assess air pollution impacts and provide meaningful valuation.	General population survey	- WTP to reduce health effects is about 2/3 of total WTP to reduce pollution, on average. - Income is positively related to WTP.	WTP estimates not useful for morbidity valuation due to uncertainty about the change in morbidity being valued.

Table 1

Summary of Studies Reviewed

(continued)

Authors (Year)	Type of Approach	Brief Description	Crucial Assumptions	Data Sources	Important Findings (1983 dollars)	Usefulness for Pollution-Related Morbidity Valuation and Other Comments
Loehman et al. (1981)	Contingent valuation	Survey of San Francisco area residents concerning WTP for reductions in air pollution, separating health and visibility effects. Replication of Brookshire et al. (1979).	General public is able to reasonably assess air pollution impacts and provide meaningful valuation.	General population survey	- WTP to reduce or prevent health effects is about 1/2 of total WTP to reduce pollution, on average, but WTP for health and visibility are not necessarily additive. - Current health and income affect WTP.	WTP estimates are not useful for morbidity valuation due to uncertainty about the change in morbidity being valued.
Schulze et al. (1983)	Contingent valuation	Survey of Los Angeles area residents regarding a severe ozone episode that recently occurred, asking WTP to prevent the episode, focusing on the health effects of high levels of ozone.	Responses about a specific episode in the past can be generalized.	General population survey	WTP is influenced by individual's preferences for outdoor recreation.	WTP estimates are not useful for morbidity valuation because interpretation of WTP to have avoided a past episode is not clear.
Sintonen (1981)	Health Status Index	A health index was developed using 12 health dimensions with 5 to 7 levels of health in each dimension. Two psychometric scaling techniques were used -- the category method and magnitude method -- by a general population sample to estimate weights for the index.	- An additive model implying independence between the health dimensions is appropriate. - Individuals can accurately rank the desirability of different health states.	General population survey	- Two health index functions were estimated using different scaling techniques. The value rankings implied by each function were closely correlated. - The survey participants indicated that the approach was understandable.	It is useful in that it constructs a ranking of health states that is based on function impairment and is disease independent with weights obtained from a general population survey. - This approach does not estimate the value in monetary terms of alternative health states. However, it provides a base description and ranking of health states that could be used in a contingent valuation study.

Table 1

Summary of Studies Reviewed

(concluded)

Authors (Year)	Type of Approach	Brief Description	Crucial Assumptions	Data Sources	Important Findings (1983 dollars)	Usefulness for Pollution-Related Morbidity Valuation and Other Comments
Torrance et al. (1982)	Health Status Index	A four dimensional health state classification system was used as the basis for a health status index. A multiattribute utility function was constructed that allowed for health dimensions to be either substitutes or complements.	A multiplicative functional form is an appropriate approximation of the individual's utility function -- independence between health dimensions was not assumed, but the interaction between the dimensions was subject to a number of constraints.	General population survey in Ontario, Canada	The study found the different health dimensions to be complements for the individuals interviewed. The condition of additive independence was tested and rejected. - Survey participants claimed to understand the questionnaire and procedures.	The study constructs a health status index based on a functional classification that is disease independent. This health state classification could be used in a contingent valuation study to obtain monetary valuations for changes in health status.
Rosser and Kind (1978)	Health Status Index	A simple set of health states was constructed using two dimensions -- one relating to physical and mental disability, and the second relating to pain and distress. An index for these health states was constructed using magnitude and ratio scaling methods.	The simplified health state classification system used is an adequate description of alternative health states.	A survey of health professionals and selected patients	- Individuals' perceptions of the desirability of health states changed over the course of the interview. - The rankings of states varied with current experience of illness but not past experience. - Socioeconomic variables did not influence health state rankings.	This type of simplified function/dysfunction analysis of health states that is disease independent could be very useful as a starting point for a contingent valuation study.

2. Acute and chronic illness should be approached differently. Acute illnesses can typically be accomodated in an individual's life by temporary changes in work and leisure activities, allowing the individual to return to the same lifestyle once he or she recovers. Chronic illnesses, on the other hand, typically mean a permanent change in an individual's routine and lifestyle. In general, the estimation of WTP (WTA) for changes in acute illness is less complicated than for changes in chronic illness, because permanent lifestyle changes are difficult to evaluate. For example, CV surveys are known to be more effective when concerned with experiences that are familiar to respondents, implying that obtaining CV estimates for changes in the risks of experiencing short term respiratory infections would be less problematic than obtaining CV estimates for changes in the risks of experiencing a chronic condition such as emphysema with which the respondent has little familiarity. The impacts of developing a chronic condition could include substantial effects on family members and friends as well as on the affected individual. A long term disability can change the individual's role in a family and in a community. Current WTP (WTA) estimation approaches are very limited in their ability to quantify these kinds of impacts. Acute illnesses can also affect family, friends, employers and taxpayers, but these impacts are defined more easily.

3. The appropriate measure of morbidity may vary. For any effort to estimate WTP (WTA) for changes in morbidity, the change in morbidity must be clearly defined. It might be defined as a change in the number of people expected to come down with a specific illness in a given time period, or it might be measured as a change in a general level of illness, such as work loss days or restricted activity days. It might also be measured as a change in some sort of health status dimension used in the HSI studies. The choice of a measure of morbidity will depend in part on the information available about the effects of the pollutants under consideration, and the choice of a morbidity measure will in turn influence the approach used for estimating WTP (WTA) for the change in morbidity. Most important, the appropriate measure of morbidity will depend on the potential change in pollution being evaluated and what the morbidity effects are expected to be.

4. WTP (WTA) for changes in morbidity is influenced by the current health of the individual. There is some evidence that individuals who are in worse health are willing to pay more to prevent additional morbidity or to reduce current morbidity. This is consistent with what might be expected on theoretical grounds since those

with lower health levels may value increments of health more highly. This is important for environmental policy considerations because in many instances the group at risk is a "sensitive" population that already has some health problems rather than the general public.

SUMMARY OF THE REVIEWS

HPF Studies

Cropper (1981), Gerking et al. (1983) and Harrington and Portney (1982) have developed models of individual behavior that incorporate the concept that people make expenditures of time and money in order to protect and maintain their health.[1] This means that the observed effects of pollution on human health reflect only part of the disutility of pollution. The other part is the opportunity cost of the resources devoted to avoiding or mitigating additional health effects. The HPF models show the different ways pollution can be expected to affect an individual's utility, through actual or potential effects on his own health.

Expressions for WTP (WTA) for changes in pollution have been derived from these models. The results of these analyses suggest ways to approach the estimation of WTP (WTA) and give criteria by which to evaluate the completeness of other WTP (WTA) estimates. This is the most useful contribution of these studies to date. The empirical estimates that have been made must be interpreted in the context of the data limitations and assumptions used. More work needs to be done before policy relevant estimates of WTP (WTA) can be obtained with this approach.

Harrington and Portney provide a more general HPF model than Gerking et al. or Cropper. The expression that they derive for WTP (WTA) for changes in health related pollution includes the following four components:

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[1] An extensive HPF literature has developed since the seminal article by Grossman (1972) with a wide variety of applications. This review is limited to those HPF studies that specifically address WTP (WTA) for pollution-induced changes in morbidity.

- The opportunity cost of the change in time spent sick due to the change in pollution

- The change in medical expenditures associated with the change in time spent sick as a result of the change in pollution

- The change in defensive expenditures associated with the change in pollution

- The direct disutility (the pain and discomfort) associated with the effect of the change in pollution on the individual's health

In all of the HPF models the opportunity cost of time spent sick is interpreted as the individual's marginal wage rate. If this assumption is accepted it allows a fairly straightforward approach to estimating a value for this component. Available information about medical expenditures can also be used to estimate a value for the second component. The third and fourth components pose more problems, which the Cropper and Gerking et al. studies have tried to address, at least in part. On the basis of their expression for WTP (WTA) Harrington and Portney argue that under reasonable assumptions WTP (WTA) can be expected to exceed income lost and medical expenditures incurred due to illness.

The model developed by Cropper includes only the first and third components of WTP (WTA) for changes in pollution. In other words, it was assumed the only avenues by which pollution affects the individual's well-being are through the opportunity cost of changes in time spent sick and through defensive expenditures and activities (including preventive medical care). Assuming specific functional forms for the relationship in the model, Cropper demonstrated that these two components of WTP (WTA) would be equal. The empirical estimate of WTP for a change in pollution was therefore simply two times the change in time spent sick, times the wage rate.

Gerking et al. include the direct utility effects of health in their model, as well as the opportunity cost of time spent sick and defensive expenditures in response to pollution. They, however, derive an expression for WTP (WTA) that depends only on the relationships between health and pollution and between health and defensive expenditures and on the price of defensive expenditures. This expression shows promise for empirical estimation because the direct effects of utility, which cannot be directly observed, have

been eliminated. The empirical estimates are acknowledged by Gerking et al. to be flawed by data limitations. These problems illustrate the difficulties in specifying a health production function that is useful for empirical analysis.

COI Studies

The COI studies refer to an extensive research area that has been concerned with estimating the economic burden of illness on society. Three categories of costs are typically discussed in the COI literature:

1. Direct costs are for preventive medical care, treatment, extended care, and rehabilitation related to illness.

2. Indirect costs are goods and services that do not get produced due to morbidity or premature mortality.

3. Psychosocial costs are the pain, suffering and emotional distress incurred by patients, family and friends.

Most COI studies develop quantitative estimates of direct and indirect costs associated with all illness or with specific diseases. Psychosocial costs are usually acknowledged as potentially important, but are treated as nonquantifiable. For evaluating programs to prevent or reduce health related effects of environmental pollution, the question is how direct and indirect costs of illness can be expected to be related to WTP (WTA) for changes in health. For the most part, they can be expected to be a lower bound on total social WTP (WTA) for changes in pollution-induced morbidity, because they do not include all the expenses of time and resources associated with the preventive medical care or mitigation of health effects (such as exercise or changes in activities to reduce exposure to pollution), or the pain and inconvenience associated with illness for the patient as well as family and friends. In this light, COI studies are a useful source of information for policy makers concerned with the health effects of environmental pollution.

The COI literature is extensive and a detailed review was beyond the scope of this report. Hu and Sandifer (1981) review 238 COI studies for specific illnesses. In many cases there is enough information readily available to develop new COI estimates for a

specific pollution related health effect under consideration. Mullner et al. (1983) have compiled an inventory of national health care information data bases that might be of use for COI studies.

Specific applications of COI for environmental policy issues should consider whether to use incidence or prevalence based estimates. Incidence based estimates are all the costs associated with each case of a disease that begins in a given year, from its onset until recovery or death occurs. Prevalence based costs reflect all the costs associated with all cases of a disease (new or old) that are incurred in a given year. Incidence based costs may be more relevant for pollution induced health effects, if, for example, a reduction in pollution means that fewer people will come down with a specific illness. Incidence based cost estimates are, however, more difficult to obtain and have received less attention in the COI literature. On the other hand, if the reduction in pollution shortens the time spent ill (for any average case), prevalence-based costs may adequately reflect both the reduction in number of cases and in the length of illness.

An important difference between standard COI estimates and pollution induced health issues is that the latter are typically concerned with a change in the incidence or prevalence of a condition, while COI estimates are typically for all cases of a given condition. This means that some procedure must be used to determine what part of the COI estimate would be associated with a given change in pollution. The appropriate procedure will depend on the pollution change being considered and the type of information available to the analyst. It is often assumed that changes in COI are proportional to the change in illness. This implies an assumption that the people affected by the pollution are representative of the population of all people with that illness in terms of socioeconomic characteristics, such as income. It also assumes that the pollution induced health effect is typical of most cases of that illness in terms of medical costs. The validity of these assumptions and the possibility of making adjustments when they are not considered acceptable will have to be considered on a case by case basis.

Cooper and Rice and (1976) Hartunian et al. (1980, 1981) are two COI studies that were reviewed in more detail because they illustrate current practice in COI estimation methods and their results are potentially useful for pollution related COI studies. Cooper and Rice developed prevalence based COI estimates for all illness and premature death in the U.S. in 1972. These costs were allocated among 16 disease categories. Their results have been frequently applied to more specific COI questions. They are useful for

developing quick COI estimates for broad categories of morbidity. For example, Manual et al. (1983) use the Cooper and Rice results to estimate the change in direct medical expenditures that could be expected to be associated with a change in work loss days as a result of a change in ambient particulate levels.

Hartunian et al. (1980, 1981) estimate incidence based COI estimates for 1975 for four types of conditions: cancer, motor vehicle injuries, coronary heart disease and stroke. The Hartunian et al. studies set the methodological example for incidence based COI estimation and their results are potentially useful for environmental pollution applications for the disease categories covered.

CV Studies

Two CV studies (Loehman et al., 1979, and Rowe and Chestnut, 1984) provide estimates of WTP for changes in specific kinds of morbidity: acute respiratory symptoms for the general population and changes in the frequency of symptoms for people who already have asthma. Due to uncertainties in any CV estimation, these numbers should be used cautiously until they are verified in repeated estimations. CV approaches of this type seem to be most applicable for changes in acute illness that are familiar to the survey population (this includes aggravation of chronic conditions that people already have).

The results of the study by Loehman et al. are applicable with regard to the prevention of some short term respiratory symptoms. These include shortness of breath, head congestion and coughing/sneezing. These symptoms were characterized as minor, causing little interference with normal daily activities, or severe, causing considerable interference with normal daily activities. Median WTP estimates obtained were highest for shortness of breath and lowest for coughing/sneezing. Median WTP to prevent one day of minor symptoms ranged from about $3 to $8 (1983 dollars), and to prevent one day of severe symptoms ranged from about $11 to $18.

Rowe and Chestnut (1984) found mean WTP by a sample of asthmatics for a 50 percent reduction in "bad asthma days" to be about $400 (1983 dollars) per year. The respondents were asthmatics with an average of 38 "bad asthma days" per year, so this was an average of about $21 per bad asthma day reduced. The results of this study also indicate that an individual's WTP for a reduction in asthma symptoms is as much as 1.6 to 2.3

times the estimated sum of direct medical expenditures and income lost incurred by the individual.

Other contingent valuation studies (Brookshire et al., 1979; Loehman et al., 1981; and Schulze et al., 1983) were discussed that do not provide estimates of WTP for specific changes in morbidity, but provide some information about WTP for changes in pollution levels that are associated with health effects. The results of these studies and the two mentioned above support the following points concerning WTP for changes in morbidity:

- WTP to prevent a deterioration in health can be expected to exceed WTP to obtain the same size improvement in health.
- WTP of people in poor health tends to exceed WTP of people in good health.
- Higher household income may mean higher WTP.
- Total WTP of men and women are not significantly different (in contradiction to COI estimates that show higher values for men due to higher wages).
- Insurance coverage may mean lower individual WTP.

HSI Studies

The HSI studies reviewed do not provide any dollar estimates of value for changes in morbidity, but they provide guidelines for characterizing changes in morbidity that could be used in future valuation studies. The health status classifications developed in this literature are typically function and symptom oriented, not disease specific. This function/dysfunction approach is appealing for benefits analysis because it incorporates the factors that directly influence an individual's quality of life with respect to health. In addition, a suitable health status classification system could simplify the benefits estimation problem. The number of possible health effects that are environmentally caused or aggravated is potentially large. It would be very difficult to conduct a separate benefits study for each illness. A more tractable approach may be to define a set of

health dimensions, similar to those developed in the HSI literature by Torrance et al. (1982), Sintonen (1981) and Rosser and Kind (1978), that could be used to characterize the health effects of different pollutants. Changes in these function/dysfunction based health states could then be valued and used to deduce the benefits of preventing or reducing illnesses that cause these symptoms. This classification system could incorporate a time dimension so that both chronic and acute effects could be included. However, health status index studies to date have not incorporated time in this manner.

HSI studies ask individuals to rank different health status levels according to the perceived disutility, or utility, associated with each health state. The results of these rankings provide useful information for future surveys concerning the valuation of health. Rosser and Kind demonstrate that individuals do not necessarily have well formulated values, especially with respect to health states with which they have no previous experience. When conducting CV studies or surveys to construct a health status index, the standard assumption is that individuals have well formulated values and the goal of the survey is to elicit those values. However, in some instances individuals may not have previously considered the tradeoffs in the way they are being addressed in the study and may have to formulate their opinions during the course of the interview. Some respondents found that their values had changed from the beginning to the end of the exercise. This means that the survey instrument itself is extremely important because it can influence this value formulation process.

Rosser and Kind also investigated whether different socioeconomic subpopulations rated the health states differently. They found no significant differences between the ratings of the subgroups, except for those with different current health problems.

Most HSI surveys were well received by the subjects. Sintonen (1981) reported that the subjects generally found the questions easy to understand, although sometimes difficult to answer. Also, few subjects objected to the elicitation or found the questions impossible to answer. The HSI surveys may be more favorably received than similar willingness to pay studies would be, due to the additional difficulties of valuing changes in health in dollar terms.

RECOMMENDATIONS FOR FUTURE RESEARCH

Given the overall conclusion that we know very little about dollar values for pollution-induced changes in morbidity, additional research in any of the areas discussed would be useful. This section focuses on some specific research suggestions aimed at improving information about WTP (WTA) for changes in morbidity and applying the estimation techniques in ways for which they are most suited. They are presented roughly in order of priority, as perceived by these authors.

A contingent valuation study concerning work loss days and restricted activity days. Data on work loss days (WLD's), restricted activity days (RAD's) and bed days (BD's) due to illness are collected annually for the U.S. population by the National Center for Health Statistics (NCHS). These data have been used in several epidemiological studies concerning the health effects of pollutants. (See for examples Ostro, 1983, and Portney and Mullahy, 1983.) Estimates of dollar values for changes in these measures of morbidity have typically been based simply on the average wage rate as a proxy for the opportunity cost of time spent sick. This can be expected to provide a lower bound on total social WTP for changes in WLD's, RAD's or BD's, but how much "true" WTP might be is unknown. Better measures of value for changes in WLD's, BD's and RAD's would be useful because these measures of health effects are likely to continue to be extensively used. A suitable application of a CV approach would be to estimate individual WTP to reduce or prevent WLD's, RAD's, and BD's. Short term illnesses that interfere temporarily with normal daily activities are familiar experiences for most people, and are therefore readily addressed in a CV survey.

Health status indices and benefits research. The research on health status characterization and indices may provide a useful starting point for obtaining economic values for changes in health in a CV study. These health status classifications emphasize the function/dysfunction aspects of illness, including such things as the ability to perform the usual activities for an individual's social role as well as certain "quality of life" aspects. This type of health measure would be useful for pollution control benefits studies because it can reflect factors that affect quality of life and can incorporate a wide variety of potential health effects since it is disease independent. A health status classification that encompasses the functional effects of a variety of environmentally caused or

aggravated illness need not be complicated. The classification used by Rosser and Kind (1978), for example, resulted in thirty-two combinations describing different health states. This is few enough to allow for the direct valuation of changes between states using CV methods.

Health production function estimation. The estimation of WTP for changes in morbidity by Gerking et al. (1983) was not an adequate demonstration of the possibilities of the HPF approach due to the limitations of the data that were used. An estimate of the expression for WTP that Gerking et al. derived from the HPF model would be useful because the model incorporates the pain and suffering associated with illness for the individual, although the theoretical limitations of the model would first have to be thoroughly explored. The estimation of this expression for changes in pollution requires an estimate of the health production function -- the relationship between health and medical care, pollution and other characteristics of the individual -- and an estimate of the price of medical care. A survey probably would be needed to obtain adequate data for this estimation.

Cost of illness studies. The priorities for research concerning the value of changes in morbidity for use in benefit-cost should be to develop estimates of willingness to pay. However, the lack of adequate estimates of willingness to pay for changes in morbidity means that COI estimates will continue to be useful. It will therefore be important to keep track of new developments in the COI literature, especially in the area of incidence based costs. Improved information about marginal costs of illness versus average costs and about per person or per incident costs would also be useful for applications to pollution control issues. It would also be useful to continue to explore the expected relationship between COI and WTP estimates, as well as comparing estimates of WTP based on other estimation methods with what comparable COI estimates would have been. Effort to expand COI estimates to include more of the expected components of WTP would be useful. Mushkin (1979b) provides an example of this kind of expansion.

Morbidity as related to mortality. Many regulatory actions will affect both morbidity and mortality, so that it may be difficult to find data sets where the two effects can be assessed separately, particularly when chronic illness is involved. Since the policy need

is for a total benefit measure, a useful theoretical development would be the creation of models that combine morbidity and mortality considerations. One step in this direction would be the extension of morbidity models to allow for multiperiod decision making. Then the benefits could be calculated for present actions that reduce future time spent sick (or severity), leading to a better understanding of trade-offs that are not easy to include in a single period model. The separability of morbidity and mortality could be addressed in such a model.

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